Mission-Based T&E

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Primer Purpose

- To introduce MBT&E definitions, framework and process.
- To generate discussions.
- To solicit feedback on MBT&E methodology.

- Caveat: Information presented in this brief is **not meant** to prescribe how MBT&E **must** be implemented. MBT&E is an ongoing methodology development effort. Readers are encouraged to ask questions, suggest ideas, and improve the process.

MBT&E Introduction

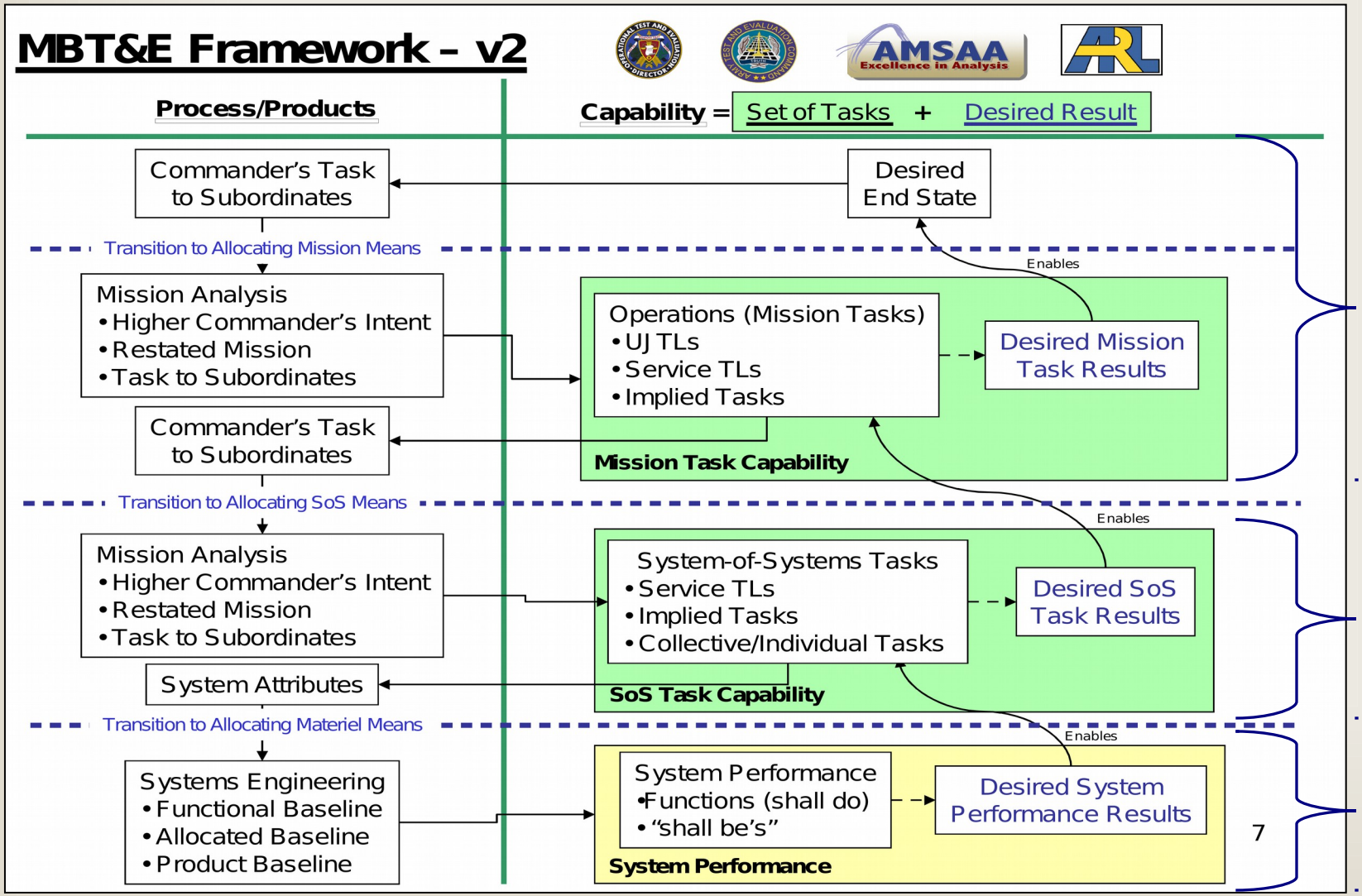
Mission-Based Test and Evaluation

is a methodology that focuses T&E on the operational **capabilities** provided to the warfighter. It provides a *framework* and *procedure* to:

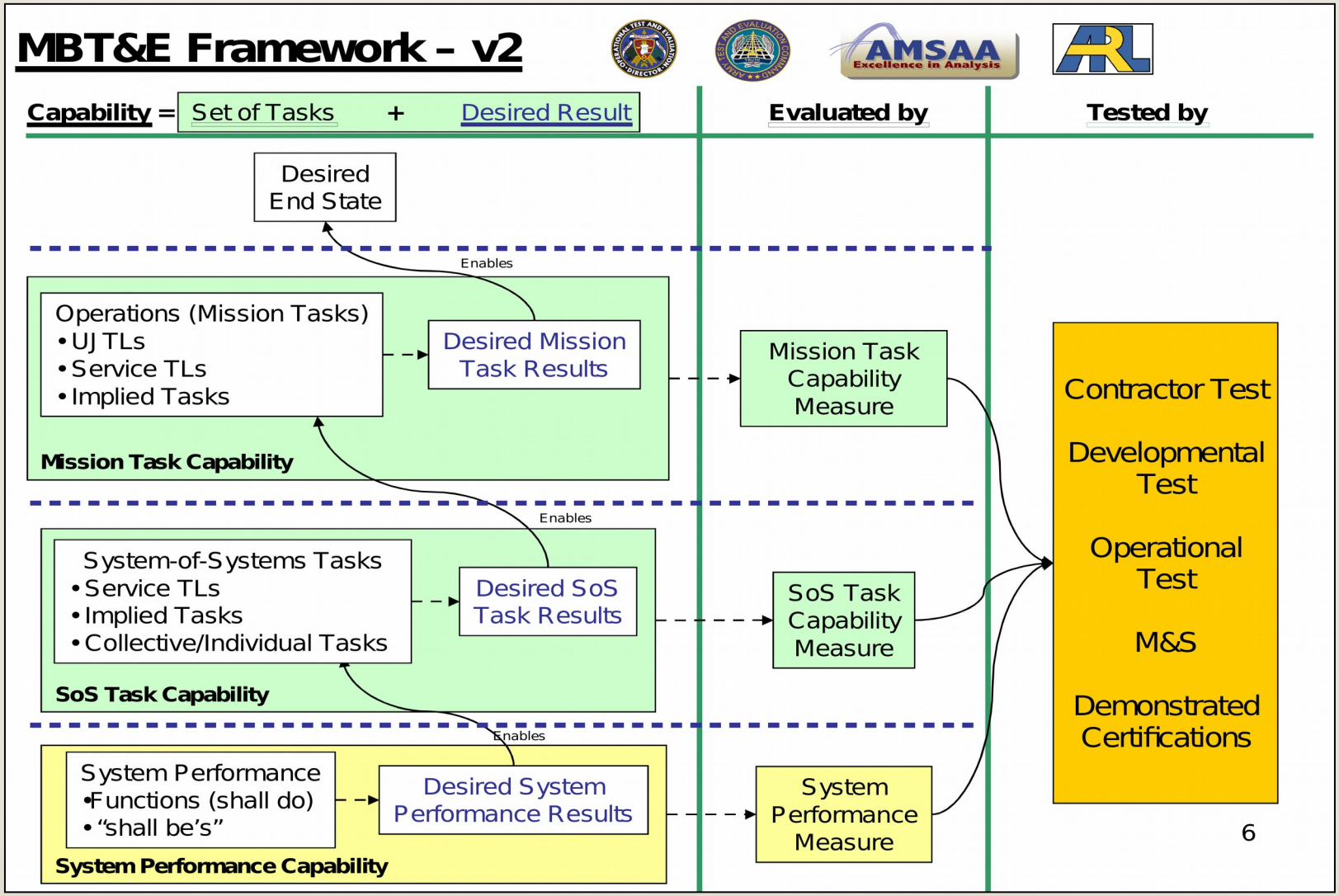
- **link operational capabilities to the attributes** of the materiel system-of-systems;
- develop evaluation measures that **assess operational capabilities and system attributes**;
- and link the evaluation measures to all **available data sources**.

MBT&E Framework

(1 of 2)



MBT&E Framework
(2 of 2)



MBT&E Procedure Overview

- Steps divided into 5 major purpose areas.
  - 1 Pre-step to understand the program context.

UNDERSTAND THE MISSION	• 4 steps to understand the military missions, operations, tasks, capabilities and operational context.
UNDERSTAND THE SYSTEM	• 2 steps to understand the components and attributes of the materiel system-of-systems.
	• 1 additional step to develop the mission to system linkages.
DESIGN THE TEST AND EVALUATION	• 7 steps to design the T&E given the mission and system understanding.
DETERMINE THE RESULTS	• 3 steps to generate, collect, analyze, and evaluate the data.
REPORT THE RESULTS	• 1 step to format and report the results.

Collect Information (Step 1)

Purpose: Collect available information to gain understanding of: initiating capability gap, mission context, system-of-systems design and required attributes, etc.

Key Activities: Search for and archive all information on…

- capability gap analysis and mission context,
  - Capabilities Based Analysis (functional area, need and solution analyses), Analysis of Alternatives, Defense Planning Scenarios, System Threat Analysis Report, etc.
- materiel solution requirements,
  - DoD Architecture Framework Products, Requirements Documents, etc.
- materiel system design.
  - Critical Technologies, Work Breakdown Structure, Performance Specifications, etc.

Key Output:

- Mission Context Library
- Capability Requirement Library
- System Description Library.

Understand the Mission

Steps required to understand the mission context, tasks, and capabilities.

- 4 Major Steps
  - Identify Mission Context (step 2)
    - Operations and threat, terrain and weather conditions.
  - Identify Mission Tasks (step 3)
  - Identify Supporting Tasks (step 4)
  - Identify and Assign Task Capabilities (step 5)

Understand the Mission

Define the Mission Context (Step 2) (1 of 2)

Purpose: Define the overall mission context that the proposed materiel solution is to support.

Requirements: "The process shall…"

- describe the **system-of-system (SoS) construct** to include materiel systems not under evaluation but required to provide warfighter capability to support the operations and capabilities.
- describe the **operational conditions (operational variables)** that a unit, system or individual is expected to operate under and may effect achievement of the capability. The conditions will be defined as expected at the time of fielding.
- describe the **high-level mission tasks** (down to the SoS task-level) and their **required results** (standards) where applicable.
- describe the **organizational and support unit/system construct.**
- align with the products of **capabilities based analysis** and **DoD Architecture Framework** products.

Understand the Mission

Define the Mission Context (Step 2) (2 of 2)

Key Activities:

- Determine Operations, Missions and Tasks
  - Develop a description and relationships of high-level operations/mission/tasks (Levels 1 and 2 of the framework).
  - Determine operations/mission/task required end states / results.
  - Determine Joint, interagency, multinational, network and SoS construct.
  - Determine organizational and support unit construct.
- Determine Operational Conditions
  - Determine the essential elements of mission, enemy, terrain and weather, troops and support available, time available, and civil considerations.

Anticipated Products:

- Operations to Missions Chart
- Mission Summary Worksheets

Understand the Mission
Identify the Mission Tasks (Step 3) (1 of 2)

Purpose: Identify the required mission tasks assigned at the SoS-level and link these tasks to applicable authoritative source.

Requirements: "The process shall…"

- describe the **SoS mission tasks supporting the evaluation of effectiveness**. The SoS mission tasks will form the "backbone" of the T&E strategy to allow comparison between current and new capabilities.

- focus documentation of the **SoS mission tasks on the "final increment"** in order to evaluate each increment's contribution to the overall required capability and to support achievement of needed capabilities with each increment.

- document the SoS mission tasks in a **temporal format**.

- SoS mission tasks will be **linked to authoritative sources** where possible and the standards and conditions from the authoritative sources will be documented.

Understand the Mission

Identify the Mission Tasks (Step 3) (2 of 2)

Key Activities:

- Conduct Mission Analysis
  - Develop SoS mission threads and alternate mission threads where applicable.
- Link to Authoritative Sources
  - Develop linkages between the tasks identified in step (3.1) and the appropriate authoritative sources.

Anticipated Products:

- List of SoS mission tasks in temporal format.
- Associated Authoritative tasks.
- Library of Mission Threads.

Understand the Mission
Identify Supporting Tasks (Step 4) (1 of 2)

Purpose: Identify the required supporting tasks that enable the execution of the SoS mission tasks.

Requirement: "The process shall…"

- determine the **conditional mission tasks supporting the evaluation of survivability**. (Conditional tasks are performed during a normal mission but are only required due to some influencing condition. Examples: *avoid threat missile, extinguish engine fire, reset network node, etc*.).

- determine the **enabling tasks supporting the evaluation of suitability**. (Mission enabling tasks

Understand the Mission
Identify Supporting Tasks (Step 4) (2 of 2)

Key Activities:

- Determine Conditional Tasks
  - Conditional tasks are performed during a normal mission but are only required due to some influencing condition.
  - Examples: *avoid threat missile, extinguish engine fire, reset network node, etc.*

- Determine Enabling Tasks
  - Enabling tasks are conducted in order to enable the SoS mission tasks (tasks developed in step 3) to be performed.
  - Examples: *train, deploy, maintain, etc.*

Anticipated Products:

- Conditional task threads.
- Enabling task threads.

Understand the Mission
Identify Capabilities (Step 5) (1 of 2)

Purpose: Identify and associate the capabilities required to execute the SoS, conditional and enabling tasks.

Requirements: "The process shall…"

- determine the **required capabilities** in terms of the ways, means, required result of that task, and the **applicable standards**.
- support documenting the required capabilities alone to **support rapid acquisition initiatives**.
- review and allocate capability requirements from **applicable requirements documents** to the tasks.
- identify tasks without previously identified capability requirements to the **T&E IPT**.

Understand the Mission
Identify Capabilities (Step 5) (2 of 2)

Key Activities:

- Identify Required Capabilities
  - Identify the capabilities required to support each task with a reference to applicable requirements sources.

- Associate Tasks with Capabilities
  - Link the capabilities determined above with the tasks determined in steps (3) and (4)

Anticipated Products:

- Task-to-Capabilities Description Worksheets.
- Library of Capabilities.

Understand the System

Steps required to understand the components and attributes of the materiel system.

- 2 Major Steps
  - Determine SoS Components (step 6)
  - Identify and Assign Component Attributes (step 7)

Understand the System

Determine SoS Components (Step 6)

(1 of 2)

Purpose: Identify the physical components of the materiel system that will provide attributes to support the mission tasks.

Requirements: "The process shall…"

- determine the **components of the materiel system** end items that will be required to support the applicable tasks and capabilities.
- determine the **training and support systems** required to support the materiel system.
- align identified components with the products developed by **Systems Engineering** and DoDAF, (e.g., work breakdown structures, system views, etc.).
- identify **technology risk areas** to allow development of mitigation strategies for the materiel system prior to the system design and development.

Understand the System

Determine SoS Components (Step 6)

(2 of 2)

Key Activities:

- Develop a materiel system description - starting at the SoS level and decompose the major end items into components.
  - Components at the lowest level should be able to be linked to identifiable system attributes.
- Develop human-system interface description.
- Develop detailed system fault trees for use in M&S applications.
- Identify technology and program risk areas for pre-MS B systems.

Anticipated Products:

- System Component Chart

Understand the System
Develop System Attributes (Step 7)

(1 of 2)

Purpose: Identify the materiel system attributes and associate them with the system components.

Requirement: "The process shall…"

- determine the **attributes of the system components** that will be required to support the capabilities.
- review and allocate system attribute standards from **applicable requirements sources**, to include system performance specifications.
- align identified attributes with the products developed by **Systems Engineering**.

Understand the System
Develop System Attributes (Step 7)

(2 of 2)

Key Activities:

- Identify Attributes Required
  - Identify the materiel system's attributes required to support the applicable tasks and capabilities - with a reference to applicable requirements sources.

- Associate Components with Attributes
  - Link the attributes determined above with the system components developed in step (6).

Anticipated Products:

- Component-to-Attribute Description Worksheets.

Understand Mission and System

One step required to tie the understanding of the mission with the understanding of the system.

- Associate Capabilities with Component Attributes (step 8)

Mission and System
Associate Capabilities with Attributes (Step 8) (1 of 2)

Purpose: Develop the relationships between capabilities identified in step (5) and the materiel system component attributes identified in step (7).

Requirement: “The process shall…”

- **establish the linkages** between the required capabilities and the required system component attributes.

- determine **enabling attributes supporting the evaluation of suitability**.

Mission and System Associate Capabilities with Attributes (Step 8) (2 of 2)

Key Activities:

- Link the system attributes to the capabilities.
  - Determine how the system components support the capabilities.
  - Determine redundant component support functionality.

- Determine Enabling Attributes
  - Enabling attributes of the system are not specifically tied to a particular task – they address all tasks. Examples: reliability, maintainability, etc.

- Develop degraded capability states to support M&S applications.

Anticipated Products:

- Task Description Worksheet with supporting system attributes.

Design the T&E

Steps required to design the test and evaluation program given the mission(s) and materiel system.

- 7 Major Steps
  - Develop Unconstrained Operational Conditions (step 9)
  - Develop Evaluation Strategy (step 10)
  - Develop Evaluation Measures (step 11)
  - Assign Measures to Data Sources (step 12)
  - Develop Constrained Operational Conditions (step 13)
  - Develop Data Source Requirements (step 14)
  - Develop T&E Databases (step 15)

Design the T&E
Unconstrained Operational Conditions (Step 9) (1 of 2)

Purpose: Develop the unconstrained operational conditions that should be addressed through the T&E.

Requirement: “The process shall…”

- determine the **operational conditions** applicable to each mission task capability and the applicable system component attributes supporting the capability.

- develop unconstrained **use case scenarios**.

Design the T&E
Unconstrained Operational Conditions (Step 9) (2 of 2)

Key Activities:

- Determine the operational conditions that T&E needs to address given:
  - the capability required and
  - the system attribute.

Anticipated Products:

- Task Description Worksheets with operational factors and conditions.
- Enabling Attribute Worksheets with operational factors and conditions.

Design the T&E
Develop the Evaluation Strategy (Step 10) (1 of 2)

Purpose: Develop a summary description of the evaluation to support an early strategy review.

Requirement: "The process shall…"

- develop an early-on **evaluation strategy (early with continuous updates)** that will show the linkages between the mission tasks, capabilities, system components, and component attributes.

Design the T&E
Develop the Evaluation Strategy (Step 10) (2 of 2)

Key Activities:

- Develop the early strategy review brief from the mission, task, and system worksheets developed in steps (2) through (9).

Anticipated Products:

- Mission Summary.
- Task Summary Chart.
- System Summary Chart
- Lens Chart

Design the T&E
Develop Evaluation Measures (Step 11) (1 of 2)

Purpose: Develop the evaluation measures.

Requirement: "The process shall…"

- develop evaluation measures **(mission task capability measure)** used to assess achievement of assess high-level mission required results.
- develop evaluation measures **(SOS task capability measure)** used to assess achievement of SoS task capabilities.
- develop evaluation measures **(system performance measure)** used to assess achievement of materiel system attribute performance requirements – includes both SoS and component levels.
- develop **data analysis procedures** for each measure.

Design the T&E
Develop Evaluation Measures (Step 11) (2 of 2)

Key Activities:

- Develop evaluation measures summaries for:
  - task capabilities identified in the task description worksheets.
  - system attributes identified in the task description worksheets.
  - Net-Enabled Battle Command Issues.
  - Human-System Interface Issues.
- Summarize linkages from evaluation measures to system components/attributes to tasks/capabilities.
- Link measures to COIs and Criteria.

Anticipated Products:

- Task description and enabling attribute worksheets with evaluation measures.
- Detailed evaluation measure design.
- Task/System/Evaluation Summary Chart.

Design the T&E
Assign Measures to Data Sources (Step 12) (1 of 2)

Purpose: Identify the sources of data to support the analysis of the evaluation measures.

Requirements: "The process shall…"

- develop **linkages between the evaluation measures and the source of data** supporting the measure. All sources, (contractor data, DT, OT, M&S), will be considered.

- **assess the T&E program risks** of successful execution and validation of system performance requirements.

Design the T&E
Assign Measures to Data Sources (Step 12) (2 of 2)

Key Activities:

- Assign one or more data sources to each evaluation measure.
- Review data source matrix to determine:
  - T&E execution risk by assessing critical data sources;
  - Developmental risk by assessing when critical technologies are demonstrated; and
  - Determine appropriate use of M&S.
  - Determine appropriate use of virtual and constructive methods/tools.

- Anticipated Products:
  - Time-phased evaluation to data source matrix.

Design the T&E
Constrained Operational Conditions (Step 13) (1 of 2)

Purpose: Develop the constrained operational conditions by looking at the factors that can be addressed by the identified data sources.

Requirements: "The process shall…"

- identify the **operational conditions that are addressed** by the evaluation given all the available data sources.
- identify the **T&E limitations** in terms of the limitation, impact of the limitation, and any applied mitigation procedures.
- determine **use of M&S (virtual and constructive) to address T&E limitations** to include: supplementing live test data, addressing operational conditions not testable, etc.
- develop constrained **use case scenarios**.

Design the T&E
Constrained Operational Conditions (Step 13) (2 of 2)

Key Activities:

- Determine the operational conditions that can be addressed by the identified data sources.
  - These are the constrained operational conditions.
  - This also determines the operational conditions applicable to all data sources, to include, contractor and developmental tests.
- Determine the T&E limitations by comparing the constrained vs. unconstrained operational conditions.
- Prepare the Concept In-Process Review Brief.

Anticipated Products:

- Task Description Worksheets with T&E limitations.
- Enabling Attribute Worksheet with T&E limitations.

Design the T&E
Develop Data Source Requirements (Step 14) (1 of 2)

Purpose: Develop data elements required to support the analysis of the evaluation measures from each linked data source.

Requirement: "The process shall…"

- identify **data elements** required by each data source.
- identify the **sample size and appropriate run conditions** required from each data source.
- develop a **test cases** to identify the live, virtual and constructive test requirements needed to support the evaluation measures.
- **support the development/review of detailed test plans**, to include contractor test, DT and OT.

Design the T&E
Develop Data Source Requirements (Step 14) (2 of 2)

Key Activities:

- Develop detailed measure design.
- Determine data elements required from the data source.
- Determine the operational conditions required for each run, sortie or sample.

Anticipated Products:

- Measure template or measure worksheet.
- Measure worksheet with design of experiment information.

Design the T&E
Develop T&E Databases (Step 15)

(1 of 2)

Purpose: Develop database architecture to enable efficient formatting and analysis of delivered data.

Requirement: "The process shall…"

- develop **evaluation data model and databases** down to the data element level.

- **support the development of the pattern-of-analysis** and data collection plan.
  - Help identify data collection issues and gaps.

- **support the development of test databases** linking the data elements to the evaluation databases.

Design the T&E
Develop T&E Databases (Step 15)

(2 of 2)

Key Activities:

- Develop an evaluation data model from the task description, enabling attribute, measure description worksheets.
  - The evaluation data model is a representation of the information and data assets required to evaluate the system expressed in terms of entities and relationships between entities.

- Provide evaluation data model results to the tester.
  - The evaluation data model will ensure properly documented data for communication between the evaluator and the tester.

Anticipated Products:

- Evaluation data model list of entities and their relationships.
- List of primary and derived data elements for each measure.
- List of scoring criteria, factors, conditions and controls for each measure.

Determine the Results

Steps required to generate, collect, analyze and evaluate data from the data sources.

- 3 Major Steps
  - Conduct Tests and Gather Data (step 16)
  - Perform Data Analysis (step 17)
  - Generate Evaluation Results (step 18)

Determine the Results
Conduct Test and Gather Data (Step 16) (1 of 2)

Purpose: Execute the planned data source activities and collect the required data for analysis.

Requirement: "The process shall…"

- **status the collection, authentication, delivery and adequacy** of data delivered by the data sources.

- assess the **impact of program status on the T&E effort** (schedule changes, system configuration changes, etc.)

Determine the Results
Conduct Test and Gather Data (Step 16) (2 of 2)

Key Activities:

- Execute test, run M&S, record data.
- Review data for integrity and authentication.
- Adjust T&E program based on impacts of changes in schedule and system design.

Key Information Output:

- T&E program status.

Determine the Results
Perform Data Analysis (Step 17)

(1 of 2)

Purpose: Perform the data analysis procedures necessary to generate evaluation results.

Requirements: "The process shall…"

- analyze demonstrated system **attribute performance (system measures**),
- analyze demonstrated task **capability performance (mission and task measures**),
- analyze **network-enabled** battle command performance,
- **status the progress of analysis** up to impact on the successful completion of the evaluation of capabilities.

Determine the Results
Perform Data Analysis (Step 17)

(2 of 2)

Key Activities:

- Data is analyzed according to the procedures identified in step 11.
- Performance results are compared to standards identified in steps 5 (capabilities) and 7 (system attributes).

Key Information Output:

- Mission capability measure results compared to standard.
- Task capability measure results compared to standard.
- System attribute measure results compared to standard.

Determine the Results

Generate Evaluation Results (Step 18)

(1 of 2)

Purpose: To generate evaluation conclusions based on the analysis of operational capability and system attribute performance.

Requirements: "The process shall…"

- evaluate **system performance**.
- evaluate **impact of system performance** on SoS task capabilities identified in step 5.
- evaluate **SoS task capabilities**.
- evaluate the **impact of SoS task capabilities** on mission task capabilities identified in step 2.
- evaluate the **mission task capabilities**.

Determine the Results

Generate Evaluation Results (Step 18)

(2 of 2)

Key Activities:

- Determine SoS and component attribute performance.

- Task Capabilities and Limitations.
  - Determine SoS task capability C&L directly from task measure results.
  - Determine SoS task capability C&L based on system attribute measures.

- Task C&L impact to desired mission results.
  - Determine ability to achieve desired end state directly from mission task capability measure results.
  - Determine ability to achieve desired end state from SoS task capability C&Ls.

Key Information Output:

- System attribute performance.
- Task capabilities and limitations.

Report the Results

Steps required to format and report the evaluation results.

- One Major Step
  - Generate Evaluation Report (step 19)

Report the Results

Generate Evaluation Report (Step 19)

(1 of 2)

Purpose: To generate the evaluation report which will document the evaluation conclusions.

Requirements: “The process shall…”

- report materiel **system performance and its impact** on the capabilities and limitations of achieving the required capability.
- report **task capabilities and limitations**.
- report overall **effectiveness, suitability and survivability**.

Report the Results

Generate Evaluation Report (Step 19)

(2 of 2)

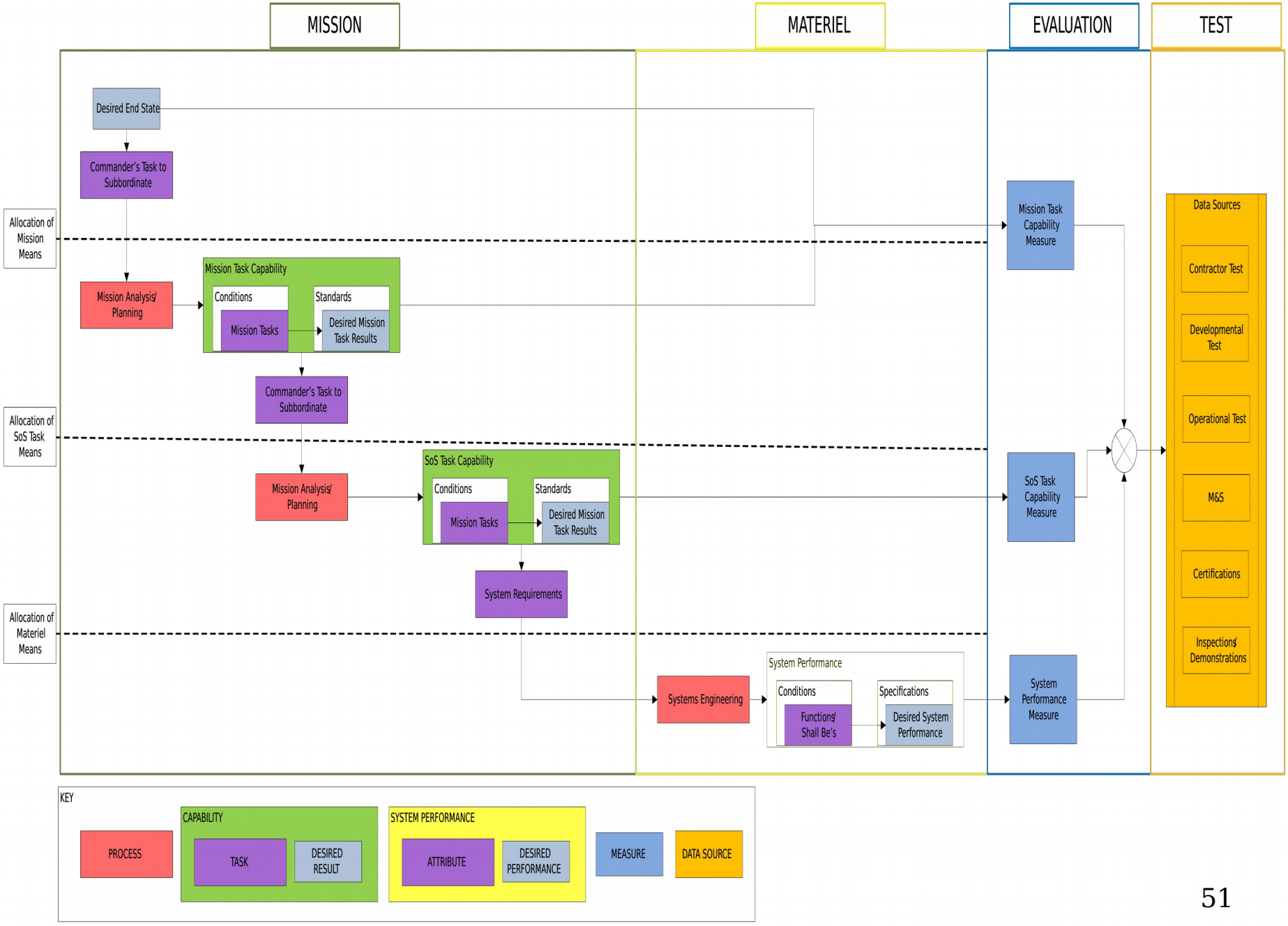
Key Activities:

- Generate SoS and component attribute performance.
- Generate system performance to the task C&L conclusions.
- Generate summary of key C&Ls.
- Generate system effectiveness, suitability and survivability conclusions.

Key Information Output:

- System and SoS performance, strengths and weaknesses and the impact they had on the operational capabilities.
- Task C&Ls and summarized mission task C&Ls.
- Overall summary of effectiveness, suitability and survivability.

Detail Framework/Process Slides


MISSION
MATERIEL
EVALUATION
TEST
Desired End State
Commander's Task to Subbordinate
Allocation of Mission Means
Mission Analysis/ Planning
Mission Task Capability
Conditions
Mission Tasks
Standards
Desired Mission Task Results
Commander's Task to Subbordinate
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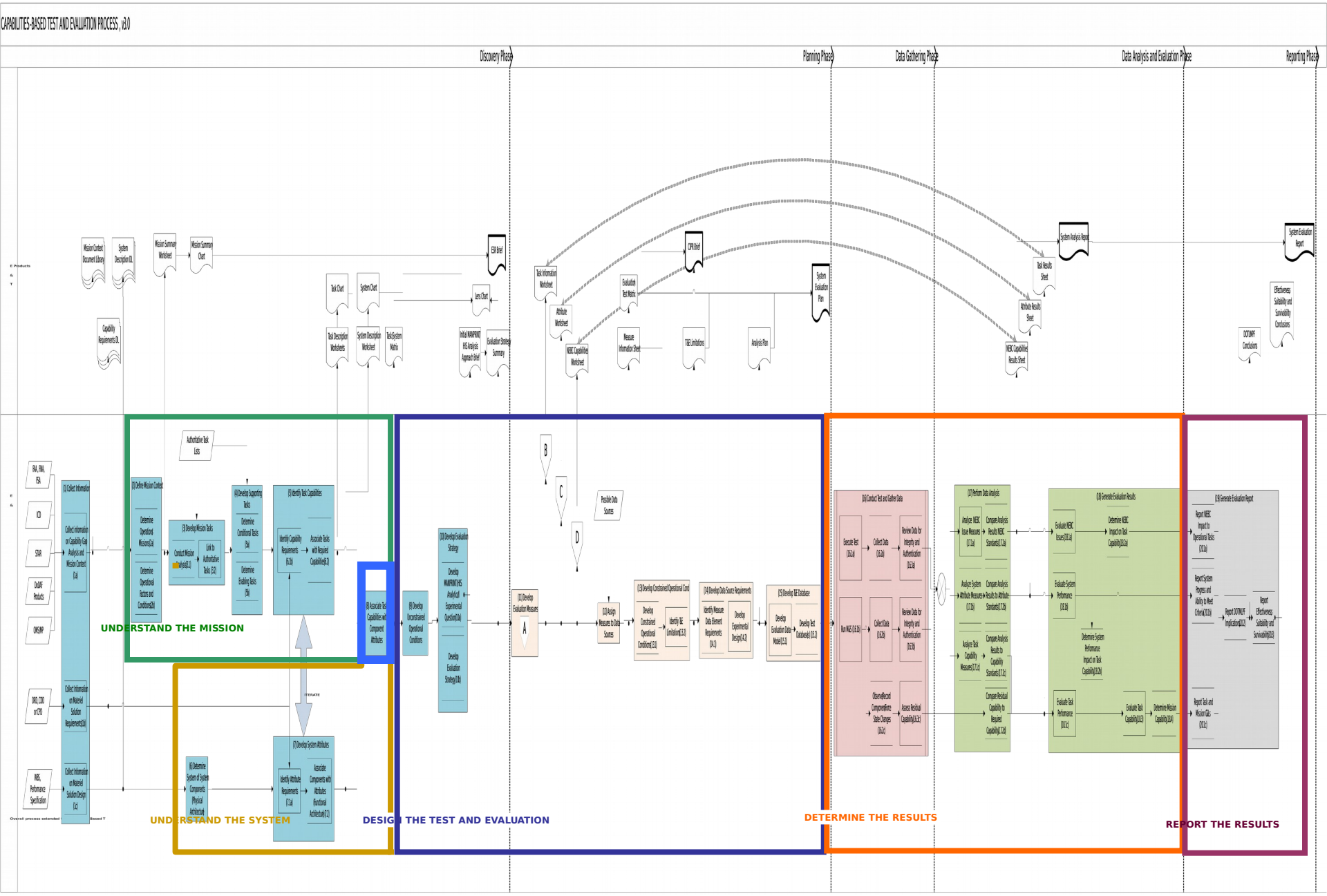
Desired Mission Task Results
System Requirements
Allocation of Materiel Means
Systems Engineering
System Performance
Conditions
Functions/ Shall Be's
Specifications
Desired System Performance
Mission Task Capability Measure
SoS Task Capability Measure
System Performance Measure
Data Sources
Contractor Test
Developmental Test
Operational Test
M&S
Certifications
Inspections/ Demonstrations
KEY
PROCESS
CAPABILITY
TASK
DESIRED RESULT
SYSTEM PERFORMANCE
ATTRIBUTE
DESIRED PERFORMANCE
MEASURE
DATA SOURCE


CAPABILITIES-BASED TEST AND EVALUATION PROCESS , v3.0
Discovery Phase
Planning Phase
Data Gathering Phase
Data Analysis and Evaluation Phase
Reporting Phase
UNDERSTAND THE MISSION
UNDERSTAND THE SYSTEM
DESIGN THE TEST AND EVALUATION
DETERMINE THE RESULTS
REPORT THE RESULTS